APPENDIX A

TOTAL MAXIMUM DAILY LOAD (TMDL) DEFINITION, PURPOSE AND CALCULATION

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TOTAL MAXIMUM DAILY LOAD (TMDL) DEFINITION, PURPOSE, AND CALCULATION & METALS STANDARDS FOR PROSPECT CREEK WATERSHED

Definitions

A TMDL is defined under Section 75-5-103 of the Montana Water Quality Act as follows:

"**Total Maximum Daily Load** or TMDL means the sum of the individual waste load allocations for point sources, and load allocations for nonpoint sources and natural background sources, established at a level necessary to achieve compliance with applicable surface water quality standards" (MCA 75-5-103 (32)).

A TMDL can also be viewed as a plan, or pollutant budget, establishing the maximum amount of a pollutant that a water body can assimilate (the water body loading capacity) without exceeding applicable water quality standards. TMDLs are often expressed in terms of an amount, or load, of a particular pollutant (expressed in units of mass per time such as pounds per day). TMDLs can also be expressed as a required pollutant load reduction.

"**Loading capacity** means the mass of a pollutant that a water body can assimilate without a violation of water quality standards. For pollutants that cannot be measured in terms of mass, it means the maximum change that can occur from the best practicable condition in a surface water without causing a violation of the surface water quality standards" (75-5-103-15).

"**Waste load allocation** means the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources" (75-5-103-34).

"**Load allocation** means the portion of a receiving water's loading capacity that is allocated to one of its existing or future nonpoint sources or to natural background sources" (75-5-103-14).

Together, the above defined terms along with a margin of safety comprise the TMDL as follows:

TMDL = Loading Capacity = SUM of Waste Load Allocations + SUM of Load Allocations + Margin of Safety

The **margin of safety (MOS)** is included in the TMDL equation to account for uncertainty regarding the relationship between pollutant loads and receiving water quality (CWA 303(d)(1)(C)). The margin of safety is typically incorporated into a TMDL through use of conservative assumptions during TMDL development, referred to as an implicit MOS. An MOS can also be included as a specific amount, or percentage of the total TMDL, referred to as an explicit MOS (U.S. EPA, 1999). TMDLs for nonpoint sources typically rely on post-TMDL Implementation Monitoring as an MOS to ensure that the TMDL targets are met. An implicit MOS, including post-implementation monitoring, has been utilized for the Prospect Creek watershed metals TMDL.

Purpose of A TMDL

A TMDL provides a framework for identification and prioritization of sources and causes of water quality impairment in a watershed, and to direct restoration efforts required to attain compliance with water quality standards and restore beneficial uses. By providing this information, the TMDL serves as a blueprint for water quality restoration planning within all, or a portion of, a watershed.

TMDL Development for Prospect Creek Watershed

Section 303(d) of the Federal Clean Water Act requires that TMDLs be established at a level, which accounts for seasonal variability in water body conditions. For metals, the stream loading capacity, and thus the TMDL, is a function of the streamflow rate (dilution capacity). For certain metals (i.e., cadmium, copper, lead, zinc) the numeric water quality criteria (target metals concentrations for the TMDL) are a function of water hardness. Therefore, the TMDL must be developed in such a manner to ensure that water quality standards are met under any streamflow or water hardness conditions.

In order to accomplish this, the Prospect Creek watershed metals TMDLs are presented as an equation yielding the stream loading capacity for any given streamflow and water hardness.

TMDL (lb/day) = X (μg/L)(Y cfs)(0.0054)

Where:
X= the numeric water quality criteria in micrograms per liter (parts per billion) for a specific metal adjusted for water hardness as necessary;
Y= streamflow rate in cubic feet per second;
0.0054 = conversion factor.

Throughout this document, flow data is given in cubic feet per second (cfs or ft^3/sec) and concentration data for most pollutants is in micrograms per liter (µg/L), which is the equivalent of parts per billion. The equation identifies the overall loading capacity to the stream under any conditions and at any time.

Water Quality Standards

Applicable Water Quality Standards

Water quality standards include; the uses designated for a water body, the legally enforceable standards that ensure that the uses are supported, and a nondegradation policy that protects the high quality of a water body. The ultimate goal of this TMDL document, once implemented, is to ensure that all designated beneficial uses are fully supported and all standards with regard to metals are met. Water quality standards form the basis for the targets described in Section 4.1. Pollutants addressed in this TMDL document include metals. This section provides a summary of the applicable water quality standards for metals in the Prospect Creek watershed.

Classification and Beneficial Uses

Classification is the assignment (designation) of a single or group of uses to a water body based on the potential of the water body to support those uses. Designated Uses or Beneficial Uses are simple narrative descriptions of water quality expectations or water quality goals. There are a variety of "uses" of state waters including: growth and propagation of fish and associated aquatic life; drinking water; agriculture; industrial supply; and recreation and wildlife. The Montana Water Quality Act (WQA) directs the Board of Environmental Review (BER, i.e., the state) to establish a classification system for all waters of the state that includes their present (when the Act was originally written) and future most beneficial uses (Administrative Rules of Montana (ARM) 17.30.607-616) and to adopt standards to protect those uses (ARM 17.30.620-670).

Montana, unlike many other states, uses a watershed based classification system with some specific exceptions. As a result, *all* waters of the state are classified and have designated uses and supporting standards. All classifications have multiple uses and in only one case (A-Closed) is a specific use (drinking water) given preference over the other designated uses. Some waters may not actually be used for a specific designated use, for example as a public drinking water supply, however the quality of that water body must be maintained suitable for that designated use. When natural conditions limit or preclude a designated use, permitted point source discharges or nonpoint source discharges may not make the natural conditions worse.

Modification of classifications or standards that would lower a water's classification or a standard (i.e., B-1 to a B-3), or removal of a designated use because of natural conditions can only occur if the water was originally miss-classified. All such modifications must be approved by the BER, and are undertaken via a Use Attainability Analysis (UAA) that must meet U.S. EPA requirements (40 CFR 131.10(g), (h) and (j)). The UAA and findings presented to the BER during rulemaking must prove that the modification is correct and all existing uses are supported. An existing use cannot be removed or made less stringent.

Descriptions of Montana's surface water classifications and designated beneficial uses are presented in Table A-1. All water bodies within the Prospect Creek Watershed are classified as B-1.

Table A-1. Montana Surface Water Classifications and Designated Beneficial Uses.

Classification	Designated Uses
A-CLOSED CLASSIFICATION:	Waters classified A-Closed are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection.
A-1 CLASSIFICATION:	Waters classified A-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities.

Table A-1. Montana Surface Water Classifications and Designated Beneficial Uses.

Classification	Designated Uses
B-1 CLASSIFICATION:	Waters classified B-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-2 CLASSIFICATION:	Waters classified B-2 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-3 CLASSIFICATION:	Waters classified B-3 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-1 CLASSIFICATION:	Waters classified C-1 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-2 CLASSIFICATION:	Waters classified C-2 are to be maintained suitable for bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-3 CLASSIFICATION:	Waters classified C-3 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agriculture and industrial water supply.
I CLASSIFICATION:	The goal of the State of Montana is to have these waters fully support the following uses: drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

Standards

In addition to the Use Classifications described above, Montana's water quality standards include numeric and narrative criteria as well as a nondegradation policy.

Numeric surface water quality standards have been developed for many parameters to protect human health and aquatic life. These standards are in the Department Circular WQB-7 (MDEQ, 2004a). The numeric human health standards have been developed for parameters determined to be toxic, carcinogenic, or harmful and have been established at levels to be protective of long-term (i.e., life long) exposures as well as through direct contact such as swimming.

The numeric aquatic life standards include chronic and acute values that are based on extensive laboratory studies including a wide variety of potentially affected species, a variety of life stages and durations of exposure. Chronic aquatic life standards are protective of long-term exposure to a parameter. The protection afforded by the chronic standards includes detrimental effects to reproduction, early life stage survival and growth rates. In most cases the chronic standard is more stringent than the corresponding acute standard. Acute aquatic life standards are protective of short-term exposures to a parameter and are not to be exceeded.

High quality waters are afforded an additional level of protection by the nondegradation rules (ARM 17.30.701 et. seq.,) and in statute (75-5-303 MCA). Changes in water quality must be "non-significant" or an authorization to degrade must be granted by the Department. However under no circumstance may standards be exceeded. It is important to note that, waters that meet or are of better quality than a standard are high quality for that parameter, and nondegradation policies apply to new or increased discharges to that the water body.

Narrative standards have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric standards. The term "Narrative Standards" commonly refers to the General Prohibitions in ARM 17.30.637 and other descriptive portions of the surface water quality standards. The General Prohibitions are also called the "free from" standards; that is, the surface waters of the state must be free from substances attributable to discharges, including thermal pollution, that impair the beneficial uses of a water body. Uses may be impaired by toxic or harmful conditions (from one or a combination of parameters) or conditions that produce undesirable aquatic life. Undesirable aquatic life includes bacteria, fungi and algae.

The standards applicable to the metals are addressed below.

Metals

Numeric criteria for metals in Montana include specific standards for the protection of both aquatic life and human health. As described above, acute and chronic criteria have been established for the protection of aquatic life. The criteria for some metals vary according to the hardness of the water. The standards for cadmium, copper, chromium (III), lead, nickel, silver and zinc vary according to the hardness of the water. These standards have an inverse relationship to toxicity (decreasing hardness causes increased toxicity). The applicable numeric criteria for the metals of concern in the Prospect Creek Watershed are presented in Table 3-3.

It should be noted that recent studies have indicated some metals concentrations vary through out the day because of diel pH and alkalinity changes. In some cases the variation can cross the

standard threshold (both ways) for a metal. Montana water quality standards are not time of day dependent.

Table A-2. Montana Numeric Surface Water Quality Standards for Metals.

Parameter	Aquatic Life (acute) (µL)[a]	Aquatic Life (chronic) (µL)[b]	Human Health (µL)[a]
Antimony	None	None	6
Arsenic (TR)	340	150	18
Lead (TR)	82 @ 100 mg/L hardness[c]	3.2 @ 100 mg/L hardness[c]	15
Zinc (TR)	67 @ 50 mg/L hardness[c]	67 @ 50 mg/L hardness[c]	2,000

[a]Maximum allowable concentration.
[b]No 4-day (96-hour) or longer period average concentration may exceed these values.
[c]Standard is dependent on the hardness of the water, measured as the concentration of $CaCO_3$ (mg/L) (see Appendix B for the coefficients to calculate the standard).
Note: TR – total recoverable.

In addition, the narrative criteria identified in Table A-3 can be applied such as in situations where excess metals loading from human activities is impacting aquatic life via elevated metals concentrations in sediment (17.30.637(1)(b). Also, narrative criteria can apply where this same type of metals loading is causing objectionable sludge deposits or emulsions in the stream.

Table A-3. Applicable Narrative Rules for Metals Related Pollutants.

Rule(s)	Standard
17.30.637(1)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will.
17.30.637(1)(a)	Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.
17.30.637(1)(d)	Create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life.

Water Hardness/Water Quality Restoration Target Interdependence

As discussed above, the aquatic water quality criteria are dependent on the water hardness (MDEQ, 2004a, Reference WQB-7; Note 12) for lead and zinc. The chronic aquatic life standard equation for these metals is identified below (WQB-7 also provides the applicable equation for acute aquatic life standards):

$$(X\ \mu g/L) = \exp\{mc[\ln(\text{hardness})] + bc\}$$

where:

X = the chronic aquatic life standard calculated as a function of hardness
mc = constant that varies by metal; values provided in WQB-7
bc = constant that varies by metal; values provided in WQB-7
hardness = hardness value in mg/l $CaCO^3$; (use 400 if >400 and 25 if <25)

For antimony and arsenic, the standard and associated targets are not a function of hardness.

Aquatic Life Support Restoration Targets

In addition to the numeric water quality standards, TMDL targets in this plan are also based on biotic indicators of macroinvertebrate and periphyton communities. These biota indicators must show no metals-related impediments to full support conditions when compared to a known reference condition as defined in MDEQ's water quality assessment process and methods document (MDEQ, 2002). Reference conditions may be determined by collecting regional reference data from a different water body possessing similar geology, hydrology, morphology and habitat conditions, and exhibiting minimal anthropogenic impacts and/or all reasonable land, soil and water conservation practices having been applied. Reference conditions can also be determined locally through comparison to a different segment of the same water body, such as an unimpaired segment from the same stream, or through comparison to an unimpaired stream segment in the same watershed. Local reference condition development must also consider most or all of the same criteria considered in the development of regional reference conditions.

Stream Sediment Metals Concentration Targets

Since there are no numeric limits for metals in sediments as there are for water, the above narrative standard can be used to justify TMDL targets to address potential excess metals concentrations in sediments. Compliance with this target will be determined through comparison of sediment metals concentrations to published values denoting potentially harmful conditions for aquatic life, in conjunction with biological assemblage sampling to verify if the aquatic life support beneficial use is being achieved.